Mohave Ground Squirrel (*Xerospermophilus mohavensis*)

Legal Status

Photo courtesy of Phil Leitner.

State: Threatened
Federal: None
Critical Habitat: N/A
Recovery Planning: No formal state or federal recovery plans have been prepared.
Note: The U.S. Fish and Wildlife Service (USFWS) published a 12-month finding on October 6, 2011, that listing of the Mohave ground squirrel (*Xerospermophilus mohavensis*) is not warranted at this time (76 FR 62214–62258).

Taxonomy

The Mohave ground squirrel (*Xerospermophilus mohavensis*) was discovered by F. Stephens in 1886 and described as a distinct monotypic species by Merriam in 1889. The type locality is the Mohave Desert near Rabbit Springs, about 24 kilometers (15 miles) east of Hesperia in San Bernardino County (Helgen et al. 2009).

The Mohave ground squirrel belongs to the family Sciuridae, which includes rodents that dig their own burrows (Gustafson 1993). Previously recognized as *Spermophilus mohavensis*, based on a review of morphometrics (measurement of external form and structure) and molecular phylogenetics (evolutionary relationships within and between groups), the Mohave ground squirrel is now recognized as *Xerospermophilus mohavensis* (Helgen et al. 2009). The Mohave ground squirrel is a distinct, full species with no recognized subspecies (Helgen et al. 2009). However, there has been some question about the recognition of the round-tailed ground squirrel (*Xerospermophilus tereticaudus*) and the Mohave ground squirrel as distinct species (Gustafson 1993; Hafner 1992; Hafner and Yates 1983). The two squirrels are closely related and have a contiguous,

but not overlapping, geographic range (Best 1995; Hafner 1992). Hafner and Yates (1983) described a narrow hybridization zone in the ranges of the two species in an area northwest of Helendale and near Coyote Dry Lake northeast of Barstow, but studies by Hafner and Yates (1983) and Hafner (1992) demonstrated that there were sufficient chromosomal, genetic, morphological, and ecological differences to warrant distinct species recognition.

Distribution

General

Endemic to California, the Mohave ground squirrel is exclusively found in the northwestern Mojave Desert in San Bernardino, Los Angeles, Kern, and Inyo counties (Best 1995; Figure SP-M05).

Distribution and Occurrences within the Plan Area

Historical

The presumed historical range of the Mohave ground squirrel within the northwestern Mojave Desert was bounded on the south and west by the San Gabriel, Tehachapi, and Sierra Nevada mountain ranges; on the northwest by Owens Lake, and on the northeast by the Granite and Avawatz mountains; and on the east and southeast by the Mojave River (Leitner 2008; MGSWG 2011). In addition, the species was historically found in one locality east of the Mojave River in the Lucerne Valley. Its historic range covered about 20,000 square kilometers (km^2) (7,722 square miles [mi^2]) (Gustafson 1993), which is the smallest geographic range of any ground squirrel species in the United States. However, for the 12-month finding for the species published in October 2011, USFWS used a somewhat larger historical range of approximately 21,525 km^2 (8,311 mi^2) (76 FR 62214–62258). USFWS also stated in the 12-month finding that the range of the Mohave ground squirrel may be larger than defined in the finding or previously published based on recent sightings such as in an interior valley of the Tehachapi Mountains and in the Panamint Valley about 8 kilometers (5 miles) north of the defined range (76 FR 62214–62258).

Based on the range used by Leitner (2008), about 88% of the historical range of the species is within the Plan Area (only the Coso Range in the northern extent of its historic range is excluded).

Prior to conversion of native desert habitats in the Antelope Valley west of Palmdale and Lancaster to agriculture and residential and commercial development, there was potential habitat for the Mohave ground squirrel, but there are no historical or recent occurrence records in this area west of State Route 14 (Leitner, pers. comm. 2012).

Approximately 28% of the California Natural Diversity Database (CNDDB) records for the Mohave ground squirrel are historical or have no date. These records are located throughout the species' range (Figure SP-M05) (CDFW 2013).

Recent

The current range may be reduced from the historical range as a result of the possible extirpation of the Mohave ground squirrel in the western portion of the Antelope Valley; although there is suitable desert scrub, there are no historical records for areas west of State Route 14. The species has been extirpated from much of the Victorville area due to agricultural and more recent rapid urban development, but there are a few recent CNDDB records, including from 2005, 2007, and 2011, for the Adelanto area (CDFW 2013; Dudek 2013; Figure SP-M05), indicating a possible relict population in the southern portion of its range (Leitner, pers. comm. 2012).

Habitat for the species has been reduced by development of agricultural uses, grazing, urbanization, military activities, energy production, and recreation (MGSWG 2011). The current occupied range is estimated to be about 19,000 km^2 (6,640 mi^2) (MGSWG 2011).

The occurrence of Mohave ground squirrel is likely to be patchy within its range, even within apparently suitable habitat (MGSWG 2011). However, as noted by Leitner (2008), occurrence records tend to be concentrated in certain areas where trapping studies have been focused; these studies are discussed in more detail below. There has not been a systematic, range-wide census or statistically based random sampling study to determine occupation throughout the

species' range (Leitner 2008). About 88% of the geographic area of known existing populations of the species, based on Leitner (2008), occur in the Plan Area (only a portion of the Coso Range-Olancha Core population is outside this area).

Recent (after 1990) records from the CNDDB and West Mojave Plan Mohave ground squirrel transect data and other California Department of Fish and Wildlife (CDFW) data include location occurrences ranging from Inyo County in the north to 3 miles southwest of Rabbit Lake in the south. The eastern extent ranges to the Granite Mountains and Fort Irwin and the westernmost record is just east of Oak Creek (Figure SP-M05) (Dudek 2013).

Leitner (2008) provides the most current status of the Mohave ground squirrel based on compilation of a database, including unpublished field studies, surveys, and incidental observations for the 10-year period from 1998 through 2007 (Table 1). This database includes 1,140 trapping sessions, of which 102 resulted in observation of the species, and 96 additional incidental observations. Most of these studies and observations have been conducted in the southern part of the species' range south of State Route 58 and no range-wide systematic or statistically based random sampling has been conducted to characterize the species' status throughout its range. Leitner (2008) emphasizes that there are large areas of potential habitat where the species' status is unknown, especially on the China Lake Naval Air Weapons Station and Fort Irwin.

Table 1. Mohave Ground Squirrel Regional Occurrence Information

Regional Location	Data Summary
Inyo County between Olancha and Haiwee Reservoir, Coso Range within China Lake Naval Air Weapons Station	Detected on five trapping grids, including Lee Flat just inside Death Valley and the northernmost occurrence record. Four other incidental records, including in north Panamint Valley several kilometers north of generally accepted range.
Ridgecrest area	Detected on 5 of 10 trapping grids in vicinity of Ridgecrest and 6 of 10 grids along State Route 176 east of Ridgecrest. No individuals trapped at two sites in Spangler Hills southeast of

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Regional Location	Data Summary
	Ridgecrest.
Little Dixie Wash extending from Inyokern southwest to Red Rock Canyon State Park	Detected on 6 of 7 trapping grids scattered throughout valley and more than 20 incidental observations. Species widespread in area.
Fremont Valley to Edwards Air Force Base	No detections in last 10 years on 6 trapping grids in Fremont Valley. Thirteen records around periphery of Desert Tortoise Natural Area (DTNA) and likely to be present within DTNA. Two incidental records northeast of town of Mojave, but protocol trapping studies in area have been negative. Ten trapping and incidental observation records for area north of Boron and Kramer Junction. Species likely widespread across region.
Wind farm southwest of Mojave (outside accepted range but appears to have suitable habitat)	No detections at 24 trapping grids southwest of town of Mojave. Two unconfirmed observations in CNDDB.
Edwards Air Force Base	Extensive monitoring conducted, with 6 observations on 40 trapping grids from 2003–2007. Distribution of species on Edwards Air Force Base is well documented.
Los Angeles County desert area	No detections on 52 trapping grids. Four positive records in small area near Rogers Dry Lake on Edwards Air Force Base.
Victor Valley to Barstow	Extensive surveys of Adelanto and western Victorville area with two trapping records and one incidental observation. One capture near intersection of U.S. 395 and I-15. These records indicate small residual population in area. No records east of Mojave River since 1955, but not well sampled in last 10 years. No detections on three trapping sites from El Mirage Dry Lake north and east toward Barstow.

Table 1. Mohave Ground Squirrel Regional Occurrence Information

Regional Location	Data Summary
Barstow area	Three records – one record about 3.5 miles south of Barstow near landfill and outside accepted range and two records west of City. One detected at the edge of alfalfa field near Harper Dry Lake and the other trapped about 6.1 miles west of Hinkley near State Route 58.
Coolgardie Mesa and Superior Valley north of Barstow	Positive records for three trapping grids and at least seven incidental observations.
Pilot Knob area	Detected five sites from Cuddeback Dry Lake east to the boundary of the China Lake Naval Air Weapons Station.

Source: Leitner 2008.

Approximately 52% of the CNDDB records are located on public lands managed by the BLM, Department of Defense, California Department of Transportation, Department of Parks and Recreation, Kern and San Bernardino counties, and the Los Angeles Department of Water and Power). Approximately 21% are located on privately owned lands. The ownership of the remaining 27% of the CNDDB records is unknown (CDFW 2013).

Natural History

Habitat Requirements

The Mohave ground squirrel occurs in a variety of desert shrubland habitats (Table 2). Although most often found in creosote bush scrub, it has also been recorded in desert saltbush scrub, desert sink scrub, desert greasewood scrub, shadscale scrub, Joshua tree woodland, and Mojave mixed woody scrub (Best 1995; 75 FR 22063–22070; MGSWG 2011). Mohave ground squirrel typically occupies areas with open vegetative cover and small bushes (< 0.6 meter (2 feet) in height) spaced approximately 6 to 9 meters (20 to 30 feet) apart (Best 1995).

Table 2. Habitat Associations for Mohave Ground Squirrel

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Supporting Information
Creosote bush scrub, Desert saltbush scrub, Desert sink scrub, Desert greasewood scrub, Shadscale scrub, Joshua Tree woodland, Mojave mixed woody scrub	Primary habitat	Active and Inactive Season	Deep, sandy to gravelly soils on flat to moderately sloping terrain with open vegetative cover	Best 1995; MGSWG 2011

Mohave ground squirrel prefers deep, sandy to gravelly soils on flat to moderately sloping terrain and will avoid rocky areas for the most part (Best 1995; MGSWG 2011). The species is not known to occupy areas of desert pavement (MGSWG 2011). Soil characteristics are particularly important because Mohave ground squirrels construct burrows to provide temperature regulation, avoid predators, and use during the inactive season (75 FR 22063–22070).

Foraging Requirements

The Mohave ground squirrel primarily feeds on plant material. In the short term, they specialize in foraging on certain plant species, but as these sources become less available throughout the active season, the Mohave ground squirrel adapts its foraging strategy to maximize energy intake, exploiting food sources that are intermittently available (75 FR 22063–22070). High water content may be a component of their food selection as plants are eaten at different times depending on their water content (Best 1995; 75 FR 22063–22070). Mohave ground squirrels consume the leaves, fruits, and seeds of a variety of annual and perennial plants, fungi, arthropods, including butterfly larvae. At various times of the year and depending on location, they may consume leaves, forbs, shrubs, and grasses of several species and genera, including creosote (*Larrea tridentata*), winter fat (*Krascheninnikovia lanata*), spiny hop-sage (*Grayia spinosa*), freckled milk-vetch (*Astragalus lentiginosus*), eremalche (*Eremalche exilis*), desert-marigold (*Baileya pleniradiata*),

langloisia (*Langloisia setosissima*), Mojave monardella (*Monardella exilis*), saltbush (*Atriplex* spp.), gilia (*Gilia* spp.), golden linanthus (*Linanthus aureus*), and Mediterranean grass (*Schismus arabicus*), as well as seeds of box thorn (*Lycium* spp.) (Best 1995; 75 FR 22063–22070; MGSWG 2011). On the Coso Range (outside of the Plan Area), about 42% of the species' diet, based on fecal samples, consisted of forbs and shrub material (primarily foliage) (MGSWG 2011). Shrubs are especially important both early and late in the active season when forbs are not available (MGSWG 2011). Winter fat, spiny hop-sage, and saltbush made up 60% of the species' shrub diet, indicating that these species are the main food source when forbs are unavailable (MGSWG 2011). It has been suggested that habitats where winter fat and hop-sage are absent may be suboptimal for Mohave ground squirrel (MGSWG 2011).

Reproduction

The Mohave ground squirrel breeding season is from mid-February to mid-March (Best 1995; Laabs 2006) (Table 3). Males emerge from hibernation in February, up to two weeks before females, and during this time they may be territorial (Best 1995). Females generally only occupy male territories for one or two days then establish their own home ranges after copulation. Recent radiotelemetry data indicate that males expand their activity areas the breeding to overlap several established female ranges, (unpublished data, Leitner, pers. comm. 2012). Males stake out the overwintering sites of females to mate with them when they emerge (MGSWG 2011).

Pregnant females are present from March through April (Leitner, pers. comm. 2012) and gestation lasts from 29 to 30 days (Best 1995). Litter sizes range from four to nine (Best 1995), though mortality of juveniles is high during the first year, especially for juvenile males (MGSWG 2011). Parental care and lactation continues through mid-May. Litters generally appear above ground in early May (Harris and Leitner 2004). Females will breed at 1 year of age if environmental conditions are suitable, but males do not mate until 2 years of age (MGSWG 2011).

The amount of fall and winter precipitation generally determines Mohave ground squirrel reproductive success. In low rainfall years (e.g., less than 6.5 cm [2.6 in.]), they may forego breeding (MGSWG 2011), and breeding may not occur for several years during prolonged

drought (Best 1995). Because of the small geographic range of the species, low rainfall can lead to reproductive failure throughout the range (MGSWG 2011). During these periods, all available forage may be converted to body fat and squirrels can enter dormancy as early as April (Leitner 1999).

Table 3. Key Seasonal Periods for Mohave Ground Squirrel

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Aestivation								X	X	X		
Hibernation	X										X	X
Breeding		X	X									
Parental Care			X	X	X							

Notes: Aestivation is the summer period of inactivity and hibernation is the winter period of inactivity.

Sources: Best 1995; Laabs 2006.

Spatial Behavior

The Mohave ground squirrel is generally only active above ground between February and July (MGSWG 2011), but the active period may begin as early as mid-January (Harris and Leitner 2004). Adults generally enter aestivation earlier than juveniles (MGSWG 2011). Timing of emergence varies geographically as it appears to depend on temperature and elevation (Gustafson 1993; Laabs 2006). Furthermore, the timing of emergence and length of the active season varies by sex, age, and availability of food resources (MGSWG 2011). Adult females and juveniles generally have longer active seasons than adult males. The active season is also longer when there is more food available, which is often correlated with greater precipitation (MGSWG 2011). Mohave ground squirrels are diurnal, spending much of the day above ground during the active season. During the inactive season, Mohave ground squirrels remain underground in burrows and enter a state of torpor (a state of reduced physiological activity or sluggishness) to conserve their energy reserves and water (Best 1995; MGSWG 2011).

Harris and Leitner (2004) conducted a 5-year radiotelemetry study of home range use by Mohave ground squirrels in the Coso Range in Inyo County. At this study site, individual Mohave ground squirrel home ranges (calculated using both minimum convex polygon and adaptive kernel methods) varied substantially by year, individual, sex, and season (i.e., mating season vs. post-mating season) (Table 4). Generally, males have larger home ranges than females, with the most pronounced differences during the mating season. Female ranges expanded during the postmating season compared to the mating season (Table 4). In drought years when reproduction did not occur, female postmating season home ranges varied inversely in relation to precipitation, which in turn is related to the amount of available forage (Harris and Leitner 2004). Female home ranges contracted in years of moderate drought and lack of reproduction, which may be a strategy to reduce energy expenditure and enter dormancy sooner (Harris and Leitner 2004). During years of high precipitation and successful reproduction, female postmating home ranges were larger in response to the need for more energy sources to support gestation and lactation (Harris and Leitner 2004). Females that were radio tracked for more than 1 year showed a high level of home range site fidelity and all individuals' home ranges exhibited overlap over different years; i.e., no females moved to entirely new home ranges (Harris and Leitner 2004).

Table 4. Mohave Ground Squirrel Home Ranges in the Coso Range[1]

Type	Median MCP Home Range[2]	Citation
Mating Season Home Range – Male	16.63 acres (range: 10.5–99.1 acres)	Harris and Leitner 2004
Mating Season Home Range - Female	1.83 acres (range: 0.70–2.3 acres)	Harris and Leitner 2004
Postmating Home Range – Male	3.06 acres[3]	FR 22063–22070
Postmating Home Range – Female	2.96 acres[3]	FR 22063–22070

Notes:
[1] The Coso Range is located north of the Plan Area
[2] MCP = minimum convex polygon
[3] The home range statistics reported in FR 22063–22070 (the 90-day finding on the petition to list the species) cite Harris and Leitner (2004), but the original paper does not appear to include these specific statistics for postmating home ranges. While these statistics appear to be consistent with Figure 1 in Harris and Leitner (2004) and are consistent with the text description of postmating home ranges, they cannot be confirmed by a review of the original paper and it is unclear how these statistics were generated for the 90-day finding on the petition.

Male home ranges during the mating season were very large and reflected long-distance movements large enough to cross the home ranges of several females (Harris and Leitner 2004). Long-distance movements (> 656 feet) were much more frequent during the mating season compared to the postmating season, and females seldom made such long movements (Harris and Leitner 2004).

Mohave ground squirrels maintain three types of burrows within their home ranges: (1) home burrows that are used overnight during the active season and usually located at the edge of a home range; (2) aestivation burrows; and (3) accessory burrows that are used during social interactions or for escape and thermoregulation during the midday (Best 1995). Burrows are typically constructed under large shrubs (MGSWG 2011).

Harris and Leitner (2005) used radiotelemetry to track dispersal movements by juvenile Mohave ground squirrels in their first year to hibernation sites. Most juveniles dispersed relatively long distances from their natal burrow area, and exhibited dispersal that is farther than other squirrels and other mammals in proportion to home range sizes (Harris and Leitner 2005). Mean male dispersal from the natal area was 9,580 feet (range: 0 to 20,439 feet) and mean female dispersal from the natal area was 2,470 feet (range: 0 to 12,670 feet) (Harris and Leitner 2005). However, with the exception of the one female that moved 12,760 feet to a hibernation site, all the females dispersed less than 1,640 feet from the natal area, indicating that juvenile dispersal is male-biased (Harris and Leitner 2005). Notably, the juveniles that dispersed more than 2,160 feet moved out of the alluvial basin where the study was located and had to cross rocky terrain with low shrub cover, which is not considered suitable habitat for the species, and at least two individuals crossed dirt roads (Harris and Leitner 2005). In addition, all but one of the individuals dispersing more than 2,160 feet left the natal area on a particular day and did not return to the natal area (Harris and Leitner 2005). Shorter dispersal movements may involve exploratory movements where juveniles return to the natal area at night before a permanent move. Harris and Leitner (2005) suggest that the relatively mobile behavior of juvenile Mohave ground squirrels may have adaptive value for connecting location populations and recolonizing sites that have experienced natural local extinctions (e.g., due to prolonged drought).

Ecological Relationships

There is little direct information on the potential role of Mohave ground squirrels in maintaining ecological relationships and processes. Their burrow systems likely provide refuge for other species that do not dig their own burrows such as snakes and lizards and potentially other small rodents. The range of the Mohave ground squirrel is entirely overlapped by the diurnal white-tailed antelope squirrel (*Ammospermophilus leucurus*), but there appears to be little direct competition between the two species (MGSWG 2011). While Mohave ground squirrels primarily forage on the foliage of shrubs and forbs, and secondarily on the seeds of shrubs and forbs, the antelope squirrel exhibits the opposite behavior of concentrating on seeds of forbs and shrubs and insects (about 25% of their diet) and secondarily foraging on foliage (MGSWG 2011). The Mohave ground squirrel is behaviorally dominant over the antelope squirrel (MGSWG 2011). As primarily a seed-eater, the antelope squirrel is also active on the surface year round (MGSWG 2011). Potential competitive relationships with birds, herbivorous reptiles (e.g., desert tortoise), or ants for food resources are unknown. They are probably prey for several natural predators, such as coyote (*Canis latrans*), American badger (*Taxidea taxus*), bobcat (*Lynx rufus*), red-tailed hawk (*Buteo jamaicensis*), golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), common raven (*Corvus corax*), and Mojave rattlesnake (*Crotalus scutulatus*) (Best 1995).

Population Status and Trends

Global: Moderate decline to relatively stable (NatureServe 2011)
State: Same as above
Within Plan Area: Same as above

Data are lacking to assess population abundance and trends for the Mohave ground squirrel (76 FR 62219). Systematic or sample-based surveys in the species' range have not been conducted at a level that allow for population estimates and comparisons over time. As discussed in Distribution, the species likely has been extirpated from portions of its former range due to urban and agricultural development, especially around the Lancaster, Palmdale, and Victorville areas.

Threats and Environmental Stressors

The primary threat to the Mohave ground squirrel has been habitat loss and fragmentation (Leitner 2008; MGSWG 2011). The Mohave ground squirrel's range has been reduced or its habitat destroyed and degraded by urban and rural development on private and public lands, agricultural development, military activities, energy projects, and transportation (Leitner 2008; MGSWG 2011; 76 FR 62214–62258). For energy projects, large-scale solar projects are particularly destructive to Mohave ground squirrel habitat because they have a large disturbance footprint and they are sited on level and gently sloping terrain that is characteristic of Mohave ground squirrel habitat (76 FR 62214–62258).

Livestock grazing and off-highway vehicles (OHVs) may also cause habitat degradation and have direct impacts on Mohave ground squirrel (Leitner 2008; MGSWG 2011; 76 FR 62214–62258).

Grazing by cattle and sheep can affect vegetative structure, disturb soils, accelerate erosion, and collapse burrows (MGSWG 2011). Cattle and sheep forage on winter fat foliage, which is also important to Mohave ground squirrel, especially in years with low precipitation and annual forb production (MGSWG 2011). Although livestock grazing is listed as a potential threat to Mohave ground squirrel, the BLM has been eliminating or reducing grazing in some areas of the species range (76 FR 62237) and grazing does not occur on military lands, state parks or CDFW ecological reserves (Leitner, pers. comm. 2012). The USFWS 12-month finding on October 6, 2011 conclude that livestock grazing is not currently a threat to the Mohave ground squirrel (76 FR 62214–62258).

OHV use is a threat to Mohave ground squirrel through direct collisions, disturbance of soil, destruction of shrubs, and facilitation of invasive species that displace native species along dirt roads and trails (MGSWG 2011). The West Mojave Plan Route Designation report indicates that 47% of 310 vegetation transects are bisected by some type of off-road vehicle track (MGSWG 2011). The four BLM-operated off-highway areas (Jawbone Canyon, Dove Springs, El Mirage, and Spangler Hills) cover over 417 km^2 (161 mi^2) within the Mohave ground squirrel's range (MGSWG 2011).

Prolonged drought is another threat to the Mohave ground squirrel. Low rainfall causes reduced productivity of annual plants, which can cause Mohave ground squirrels to forego breeding during drought periods because insufficient energy is available to support gestation and lactation (Best 1995; Harris and Leitner 2004). Local population extinction can result with prolonged drought events that suppress reproduction for several years (Best 1995). Prolonged drought events alone would not pose a serious threat to the species, considering its likely adaptations for these conditions, such as prolonged aestivation and long dispersal movements that allow for recolonization (Best 1995; Harris and Leitner 2005). However, habitat loss, fragmentation, and degradation can preclude recolonization of habitat from which local populations have been extirpated as a result of drought because the sites become functionally isolated from occupied areas (Laabs 2006).

Urban and rural uses have introduced potential impacts to Mohave ground squirrel that may occur where habitat is near development. Domestic cats (*Felis catus*) and dogs (*Canis familiaris*) may be predators and the use of rodenticides and pesticides around agricultural fields, golf courses, earthen dams, and canal levees may directly affect the species (MGSWG 2011).

Although common raven is a natural predator, their populations have increased substantially within the Mohave ground squirrel's range and they are a known predator for small mammals (MGSWG 2011). Therefore, ravens may be exerting higher predation pressure on the species than occurred historically.

Conservation and Management Activities

Conservation and management planning for the Mohave ground squirrel has been ongoing on several fronts, including by the West Mojave Plan; CDFW; the Desert Managers MGSWG; and on military installations.

The West Mojave Plan establishes a 1,726,712-acre (2,698 mi^2) Mohave ground squirrel Conservation Area on non-military public and private lands for the long-term survival and protection of the species. The Conservation Area covers about 41% of the estimated current range of the species. Public lands within the Conservation Area would be designated as a BLM Wildlife Habitat Management

Area. The West Mojave Plan established two goals for Mohave ground squirrel: Goal 1, ensure long-term protection of Mohave ground squirrel habitat throughout the species' range; and Goal 2, ensure long-term viability of the species throughout its range. The West Mojave Plan also established several objectives to meet these goals.

For Goal 1, the West Mojave Plan objectives are:

- Establish a Conservation Area for the protection of unfragmented habitat outside military installations (noted previously)
- Establish biological transition areas to minimize indirect impacts of human development on the Conservation Area
- Allow for adjustment of the Conservation Area boundary based on scientific studies
- Implement actions to ensure long-term protection of habitat for Mohave ground squirrel in the Conservation Area throughout the life of the Plan
- Annually track the loss of Mohave ground squirrel habitat resulting from Plan implementation
- Cooperate with military installations in sharing scientific information and reviewing management plans to assist managers in evaluating Mohave ground squirrel habitat protection on the installations.

For Goal 2, the West Mojave Plan objectives are:

- Per CDFW mandate, minimize and fully mitigate the impacts of the Plan's incidental take of Mohave ground squirrel throughout the life of the Plan
- Upon Plan adoption, implement studies that would determine four measureable biological parameters for the Mohave ground squirrel: (1) regional status; (2) potential "hot spots" (refugia); (3) genetic variation throughout the species' range; and (4) the species' ecological requirements
- Establish long-term study plots throughout the species' range to annually monitor populations, and fund continued

monitoring in the Coso Range (outside of the Plan Area) to provide baseline information

- Use the biological information from the above objectives to modify management prescriptions, as warranted, to ensure the long-term viability of the species.

To date, CDFW has spent approximately $800,000 funding studies that include information on genetics, diet, dispersal, and location of Mohave ground squirrels over the past several years. Also, approximately $100,000 from Section 2081 incidental permits has or will fund Mohave ground squirrel trapping administered by the Desert Tortoise Preserve Committee (MGSWG 2011).

The military has also conducted activities to inform conservation and management of the Mohave ground squirrel.

Edwards Air Force Base has completed at least 3 years of Mohave ground squirrel inventories and has monitored 60 Habitat Quality Analysis plots. Since 2003, approximately 45% of the Edwards Air Force Base has been surveyed and funds are programmed for Mohave ground squirrel inventories through 2013 (MGSWG 2011).

The National Training Center (NTC) and Fort Irwin contain 445,241 acres of Mohave ground squirrel habitat. The NTC and Fort Irwin funded trapping studies for the Mohave ground squirrel in 1977, 1985, and from 1993 to 1994. The MGSWS (2011) suggests that the three conservation areas for Lane Mountain milk-vetch (*Astragalus jaegerianus*) on Fort Irwin will work well for Mohave ground squirrel conservation. In addition, under an agreement with CDFW, the Paradise Conservation Area will be enhanced for Mohave ground squirrel by planting the species' preferred food plants (MGSWG 2011). However, at present there is no evidence that these areas support the Mohave ground and, further, these areas are generally rocky and hilly with little of the alluvial soils needed by the species (Leitner, pers. comm. 2012). There is currently no evidence that food enhancement is successful in the Paradise Conservation Area (Leitner, pers. comm. 2012).

Data Characterization

Because Mohave ground squirrel is inactive much of the year, and squirrel abundance and the length of the active season varies from year to year (MGSWG 2011), even when studies are scheduled carefully they may not be able to establish the presence or absence of the species from a site with a high level of certainty. Further, if unfavorable conditions (little fall and winter precipitation) persist for several seasons, local extirpation can occur, but re-colonization of these areas under more favorable conditions can occur. In addition, the species is not distributed continuously throughout its range independent of proposed habitat conversion (MGSWG 2011). Because trapping studies typically are sited in habitat proposed for conversion, grids and transects are not randomly or systematically placed in a manner that samples across the range of potentially suitable habitats and allows for inferences about occupation throughout the species' range. Many of the trapping studies for Mohave ground squirrel have been concentrated south of State Route 58 where most of the habitat conversion has been proposed (Leitner 2008). For this reason, there are extensive areas of the Mohave ground squirrel's range in the Plan Area that have not been studied and the species' status is unknown (Leitner 2008).

Management and Monitoring Considerations

Protection of large core areas of native habitat and adequate connections among the core areas are required to ensure the long-term survival and recovery of the Mohave ground squirrel. Ideally, biological, demographic, and genetic considerations should govern the size and location of preserve areas. As an initial recommendation for habitat conservation of currently occupied habitat, Leitner (2008) defines core areas for the species based on three objective and measureable criteria:

1. Demonstrated species persistence in an area over a long time period on the order of two to three decades;
2. Species must be currently present in multiple locations within the core area; and
3. There are substantial numbers of adults forming a viable reproductive population.

With these criteria in mind, core preserve areas need to be large enough to support populations that are resilient to natural fluctuations in size that occur in relation to precipitation patterns, including prolonged drought. Each population has to be large enough to withstand several years of no or reduced reproduction; if a drought extends so long that no reproduction occurs over a 4- or 5-year period, even the youngest cohort would likely die of old age before reproducing. Therefore, large preserve areas are needed to minimize the risk of local extinction from demographic and environmental stochastic events, as well as from the genetic problems associated with small population size, such as loss of genetic variability, genetic drift, and inbreeding depression. Smaller areas are also more susceptible to edge effects and disturbance from surrounding non-compatible land use (Laabs 2006).

Core reserves in high-quality habitats are required to support populations of the species during drought conditions and that can provide sources from which populations may expand when conditions are favorable to the species. Research conducted on the Coso Range (outside of the Plan Area) found that certain shrub species (winter fat and spiny hop-sage) appear to be important in providing forage when annual forb growth is low and thus may be critical to the persistence of populations during drought years (MGSWG 2011). However, these data are primarily from a study site at the north edge of the species' range and community (Mojave Mixed Woody Scrub) that is somewhat atypical of the majority of the species' range. Additional research into food habits and critical habitat features in creosote bush scrub and saltbush scrub habitats is needed to identify critical habitat features (Laabs 2006).

Based on the three objective criteria cited previously, Leitner (2008) identified four core areas, as summarized in Table 5. It is important to note that these core areas are only those identified so far and that with more survey data other areas may meet the objective criteria for a core area (Leitner 2008).

Table 5. Mohave Ground Squirrel Core Areas

Core Area Name	Area (acres)	Number of Positive Records (1998–2007)
Coso/Olancha	111,690	33
Little Dixie Wash	97,112	44
Coolgardie Mesa/Superior Valley	127,450	23
Edwards Air Force Base	76,761	34

Source: Leitner 2008.

As a rare species with apparent disjunct local populations, preserving naturally occurring genetic variability is critical to the preservation of the Mohave ground squirrel. Connectivity between preserve areas will be important to maintain gene flow between local populations and facilitate recolonization of areas if local extinctions occur. According to Leitner (2008), the four core areas identified are isolated from each other by distances that range from 30 to 50 miles. Leitner (2008) identified conceptual linkages between the corridors. Demographic considerations, such as home range size and average dispersal distances, should determine the width of connectivity corridors (Laabs 2006). As described previously, Mohave ground squirrels are capable of dispersing relatively long distances; the maximum juvenile male dispersal was about 3.9 miles and the maximum female dispersal was about 2.4 miles (Harris and Leitner 2005). With distances between core habitat areas of 30 to 50 miles (Leitner 2008), substantial swaths of suitable habitat between core areas will therefore be necessary.

The habitat management component of the *Draft Mohave Ground Squirrel Conservation Strategy* (MGSWG 2011) focuses on limiting habitat loss through effective conservation measures, mitigation, and compensation by avoiding and minimizing impacts to Mohave ground squirrel and its habitat and restoring and enhancing habitat. The strategy also focuses on securing and managing sufficient core habitat and corridors to maintain self-sustaining populations (MGSWG 2011). The West Mojave Plan also focuses on establishing conservation areas to protect unfragmented habitat and biological transition areas to

protect conservation areas from indirect human impacts. The West Mojave Plan includes objectives for implementing biological studies regarding the species' range, hot spots, and ecological requirements. This information would be used to inform conservation and management of the species.

Species Modeled Habitat Distribution

This section provides the results of habitat modeling for Mohave ground squirrel, using available spatial information and occurrence information, as appropriate. For this reason, the term "modeled suitable habitat" is used in this section to distinguish modeled habitat from the habitat information provided in Habitat Requirements, which may include additional habitat and/or microhabitat factors that are important for species occupation, but for which information is not available for habitat modeling.

There are 3,501,554 acres of modeled suitable habitat for Mohave ground squirrel in the Plan Area. Appendix C includes a figure showing the modeled suitable habitat in the Plan Area.

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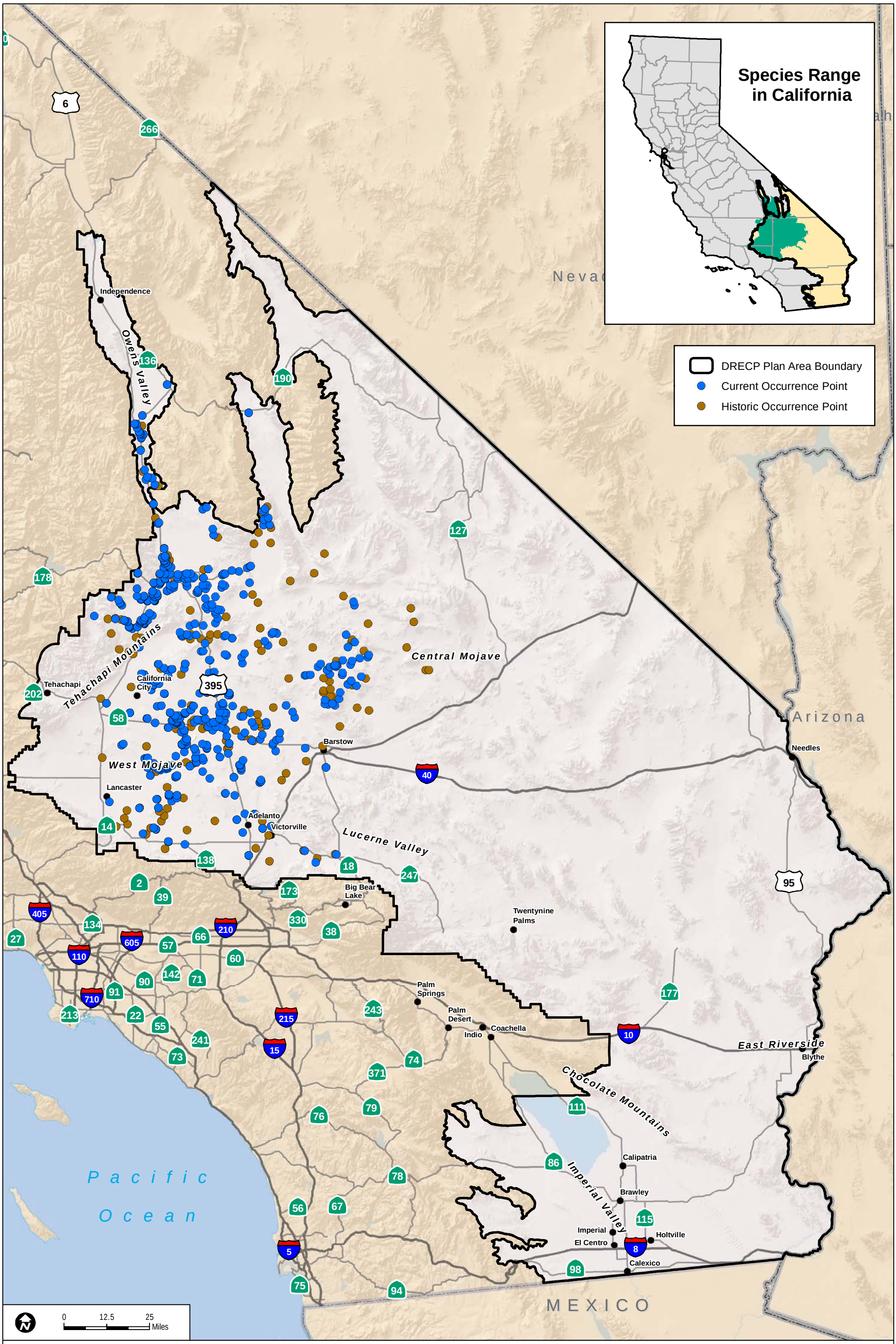

Sources: ESRI (2014); DRECP Species Occurrence Database (2013), CWHR (2008)

FIGURE SP-M05

Mohave Ground Squirrel Occurrences in the Plan Area